**Meeting of the Central Valley Flood Protection Board**
**September 23, 2010**

**Staff Report – Encroachment Permit**

**Reclamation District 3**
**Seepage Berm, Sacramento County**

---

## 1.0 – ITEM

Consider approval of Permit No. 18613 (Attachment B)

## 2.0 – APPLICANT

Reclamation District 3

## 3.0 – LOCATION

The project is located west of Ryde at River Mile 19.8.
(Steamboat Slough, Sacramento County, see Attachment A)

## 4.0 – DESCRIPTION

Applicant proposes to construct a 900-foot-long, 250-foot-wide, 3 to 5 foot thick seepage berm at the landside toe of the left (east) bank levee of Steamboat Slough.

## 5.0 – PROJECT ANALYSIS

The project area is a historical seepage site. Seepage occurred during the 2006 high water event and is still occurring, even with lower water levels. Reclamation District 3 began an investigation for designing a repair for this site that led to a Hultgren-Tillis Engineers report dated August 8, 2008 that presented three alternatives for the repair to reduce seepage 1) Seepage Berm, 2) Cutoff Wall, 3) Gravity Relief Well System. After review, Reclamation District 3 selected the seepage berm as the preferable alternative. Staff review concluded that the proposed seepage berm is the preferable alternative. The submitted geotechnical analysis and seepage design information is an attachment to this staff report.

### 5.1 – Hydraulic Analysis

No hydraulic analysis needed as the project is a landside seepage berm.

### 5.2 – Geotechnical Analysis

Staff agrees with the submitted geotechnical analysis and the recommended project design (see Attachment D).

## 6.0 – AGENCY COMMENTS AND ENDORSEMENTS

The comments and endorsements associated with this project, from all pertinent agencies are shown below:

The U. S. Army Corps of Engineers 208.10 comment letter has not yet been received for this application. Upon receipt of a favorable letter and review by Board staff it will be incorporated into the permit as Exhibit A.

Reclamation District 3 has endorsed this application without conditions. Reclamation District 3 is also the applicant for the proposed project.

## 7.0 – CEQA ANALYSIS

Board staff has prepared the following CEQA determination:

Reclamation District 3, as lead agency under CEQA, approved the project (Grand Island 2010-2011 Routine Maintenance) on June 23, 2010, and determined that the project was categorically exempt under Class 1, Section 15301 covering the repair and maintenance of existing facilities.

The Board, acting as a responsible agency under CEQA, has reviewed the Reclamation District 3 determination and has independently determined that the project is exempt from CEQA under Class 1, Section 15301 covering the repair and maintenance of existing facilities.

## 8.0 – SECTION 8610.5 CONSIDERATIONS

1. Evidence that the Board admits into its record from any party, State or local public agency, or nongovernmental organization with expertise in flood or flood plain management:

   The Board will make its decision based on the evidence in the permit application and attachments, this staff report, and any other evidence presented by any individual or group.

2. The best available science that related to the scientific issues presented by the executive officer, legal counsel, the Department or other parties that raise credible scientific issues.

   The accepted industry standards for the work proposed under this permit as regulated by Title 23 have been applied to the review of this permit.

3. Effects of the decision on the entire State Plan of Flood Control:

   This project will improve the State Plan of Flood Control as the proposed project will help to control an underseepage area and stabilize the levee.

4. Effects of reasonable projected future events, including, but not limited to, changes in hydrology, climate, and development within the applicable watershed:

   Larger flows in the Sacramento River and Steamboat Slough due global warming may require this project to be modified or enlarged.

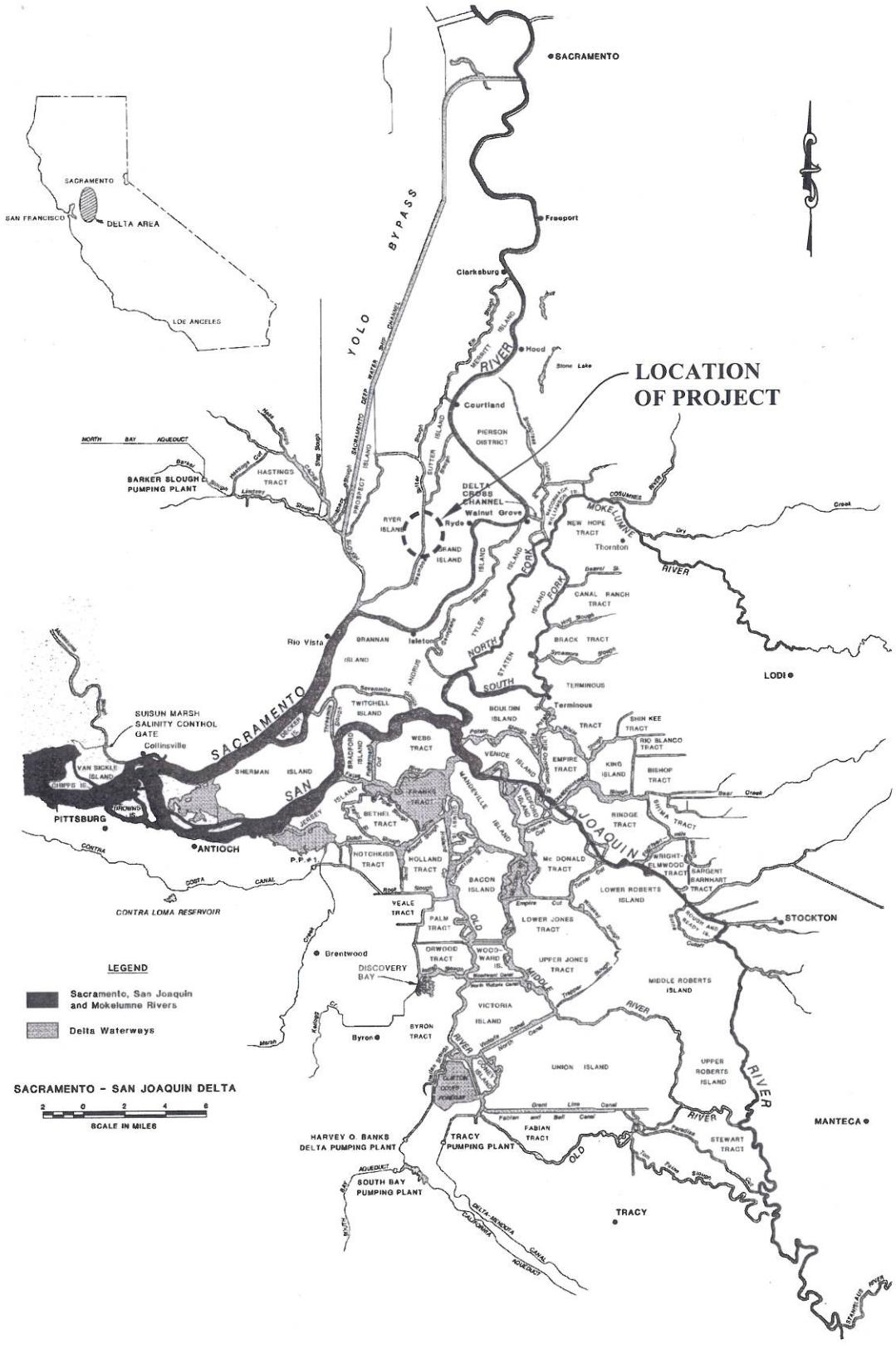
## 9.0 – STAFF RECOMMENDATION

Staff recommends that the Board determine the project to be exempt from CEQA, and to approve the permit conditioned upon receipt and review of a favorable U.S. Army Corps of Engineers comment letter.

## 10.0 – LIST OF ATTACHMENTS

A. Location Maps and Photos
B. Draft Permit No. 18613
C. Design Drawings
D. Geotechnical Report

| | |
|---|---|
| Design Review: | Steve Dawson |
| Environmental Review: | James Herota |
| Document Review: | Len Marino P.E. |




MBK ENGINEERS
1771 Tribute Road, Suite A
Sacramento, California 95815
Phone: (916) 456-4400 • Fax: (916) 456-0253

**RECLAMATION DISTRICT NO. 3**
**GRAND ISLAND**

# VICINITY MAP

| | |
|---|---|
| SCALE: | AS NOTED |
| JOB NUMBER: | 3900.1 |
| DRAWN BY: | JAB |
| DATE: | 04/14/2010 |
| SHEET: | 1 OF 5 |

R:\3900.10 RD 3 – Grand Island\2008–03 Seepage Levee survey Hultgren–Tillis\AutoCAD\Seepage Berm Design\01 – Grand Island – Vicinity Map.dwg 4–30–10 09:23:27 AM ben

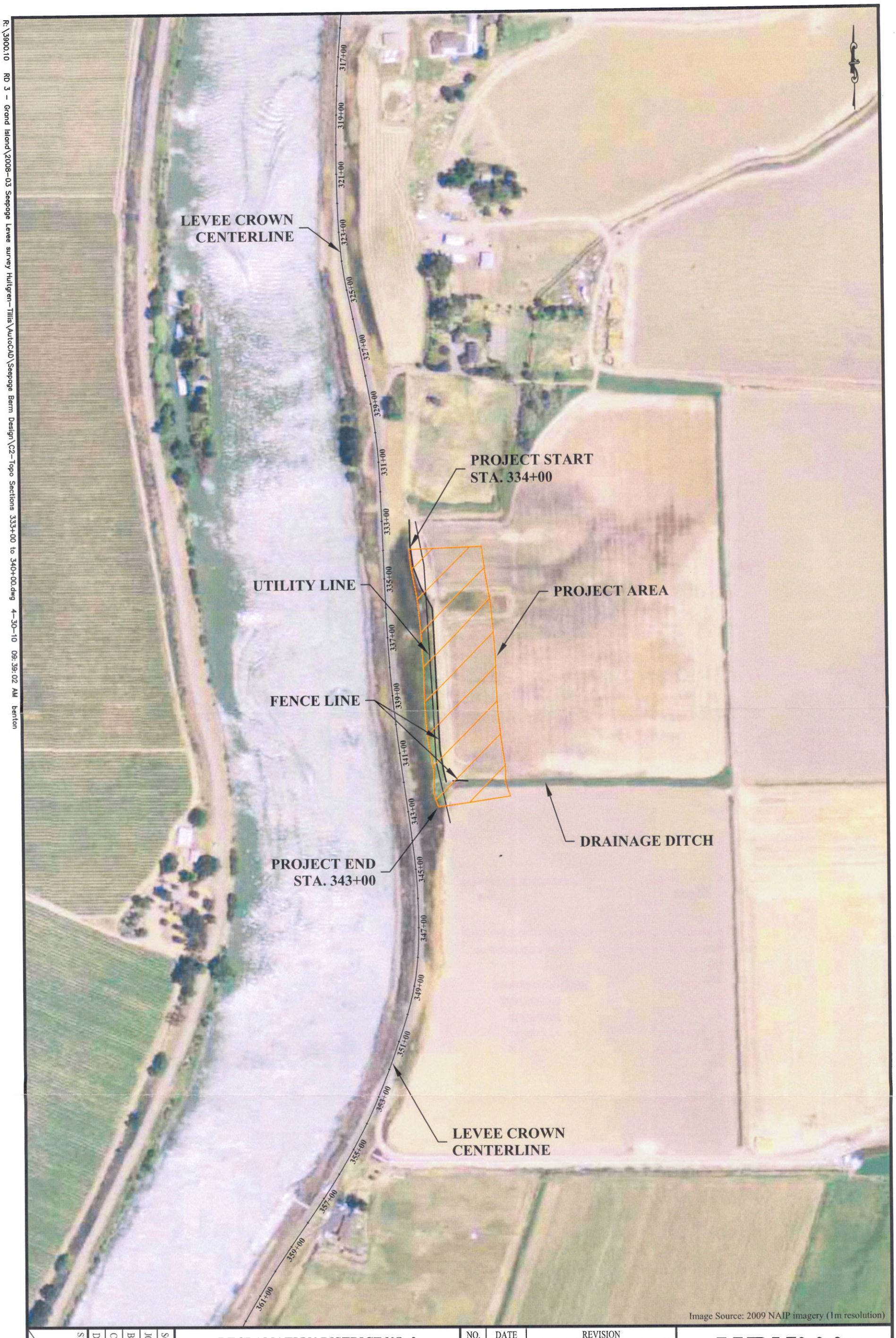



Image Source: 2009 NAIP imagery (1m resolution)

R:\3900.10 RD 3 - Grand Island\2008-03 Seepage Levee survey Hultgren-Tillis\AutoCAD\Seepage Berm Design\C2-Topo Sections 333+00 to 340+00.dwg 4-30-10 09:39:02 AM benton

| | |
|---|---|
| SHEET | 2 OF 5 SHEETS |
| DATE: | 04/16/2010 |
| CHK: | --- |
| BY: | JAB |
| JOB NO: | 3900.1 |
| SCALE: | 1" = 300' |

**RECLAMATION DISTRICT NO. 3**
**GRAND ISLAND**

# SEEPAGE BERM PROJECT AREA

| NO. | DATE | REVISION |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |

MBK ENGINEERS
1771 Tribute Road, Suite A
Sacramento, California 95815
Phone: (916) 456-4400 • Fax: (916) 456-0253

Waterside slope at Station 338+00, facing south.

Landside hinge at Station 338+00, facing south.

**RD 3 Special Projects Site – February 11, 2009**

*Photographer - Tina Lunt, Observer – Servando Diaz*

MBK ENGINEERS

Photo of seepage area from Station 338+00, facing east.

Landside hinge at Station 338+00, facing north.

**RD 3 Special Projects Site – February 11, 2009**

*Photographer - Tina Lunt, Observer – Servando Diaz*

MBK ENGINEERS

**DRAFT**

STATE OF CALIFORNIA
THE RESOURCES AGENCY

# THE CENTRAL VALLEY FLOOD PROTECTION BOARD

**PERMIT NO. 18613** BD

**This Permit is issued to**:

Reclamation District No. 3
PO Box 1011
Walnut Grove, California 95690

To construct a 900-foot-long, 250-foot-wide, 3 to 5 foot thick seepage berm at the landside toe of the left (east) bank levee of Steamboat Slough. The project is located west of Ryde at River Mile 19.8 (Section 1, T4N, R3E, MDB&M, Reclamation District 3, Steamboat Slough, Sacramento County).

NOTE: Special Conditions have been incorporated herein which may place limitations on and/or require modification of your proposed project as described above.

**(SEAL)**

Dated: _____

_____
Executive Officer

**GENERAL CONDITIONS:**

**ONE**: This permit is issued under the provisions of Sections 8700 – 8723 of the Water Code.

**TWO**: Only work described in the subject application is authorized hereby.

**THREE**: This permit does not grant a right to use or construct works on land owned by the Sacramento and San Joaquin Drainage District or on any other land.

**FOUR**: The approved work shall be accomplished under the direction and supervision of the State Department of Water Resources, and the permittee shall conform to all requirements of the Department and The Central Valley Flood Protection Board.

**FIVE**: Unless the work herein contemplated shall have been commenced within one year after issuance of this permit, the Board reserves the right to change any conditions in this permit as may be consistent with current flood control standards and policies of The Central Valley Flood Protection Board.

**SIX**: This permit shall remain in effect until revoked. In the event any conditions in this permit are not complied with, it may be revoked on 15 days' notice.

**SEVEN**: It is understood and agreed to by the permittee that the start of any work under this permit shall constitute an acceptance of the conditions in this permit and an agreement to perform work in accordance therewith.

**EIGHT**: This permit does not establish any precedent with respect to any other application received by The Central Valley Flood Protection Board.

**NINE**: The permittee shall, when required by law, secure the written order or consent from all other public agencies having jurisdiction.

**TEN**: The permittee is responsible for all personal liability and property damage which may arise out of failure on the permittee's part to perform the obligations under this permit. If any claim of liability is made against the State of California, or any departments thereof, the United States of America, a local district or other maintaining agencies and the officers, agents or employees thereof, the permittee shall defend and shall hold each of them harmless from each claim.

**ELEVEN**: The permittee shall exercise reasonable care to operate and maintain any work authorized herein to preclude injury to or damage to any works necessary to any plan of flood control adopted by the Board or the Legislature, or interfere with the successful execution, functioning or operation of any plan of flood control adopted by the Board or the Legislature.

**TWELVE**: Should any of the work not conform to the conditions of this permit, the permittee, upon order of The Central Valley Flood Protection Board, shall in the manner prescribed by the Board be responsible for the cost and expense to remove, alter, relocate, or reconstruct all or any part of the work herein approved.

**SPECIAL CONDITIONS FOR PERMIT NO. 18613 BD**

THIRTEEN: Within three years from completion of the construction of the work authorized under this permit, the permittee shall provide the Sacramento and San Joaquin Drainage District, acting by and through the Central Valley Flood Protection Board of the State of California, a permanent easement and/or a joint use agreement granting all flood control rights upon, over and across the property that will be occupied by the existing or to-be-constructed . The easement must include the area within ten (10) feet waterward of the waterward levee toe, the levee section, and the area ten (10) feet in width adjacent to the new seepage berm toes which is not presently encumbered by a Central Valley Flood Protection Board easement. For information regarding existing Central Valley Flood Protection Board Easements, please contact Angelica Aguilar at (916) 653-5782.

FOURTEEN: All work approved by this permit shall be in accordance with the submitted drawings and specifications except as modified by special permit conditions herein. No further work, other than that approved by this permit, shall be done in the area without prior approval of the Central Valley Flood Protection Board.

FIFTEEN: The permittee shall maintain the permitted encroachment(s) and the project works within the utilized area in the manner required and as requested by the authorized representative of the Department of Water Resources or any other agency responsible for maintenance.

SIXTEEN: The permittee shall contact the Department of Water Resources by telephone, (916) 574-0609, and submit the enclosed postcard to schedule a preconstruction conference. Failure to do so at least 10 working days prior to start of work may result in delay of the project.

SEVENTEEN: The permittee shall provide supervision and inspection services acceptable to the Central Valley Flood Protection Board.

EIGHTEEN: Within 120 days of completion of the project, the permittee shall submit to the Central Valley Flood Protection Board a certification report, stamped and signed by a professional engineer registered in the State of California, certifying the work was performed and inspected in accordance

with the Central Valley Flood Protection Board permit conditions and submitted drawings and specifications.

NINETEEN: Within 120 days of completion of the project, the permittee shall submit to the Central Valley Flood Protection Board proposed revisions to the Corps of Engineers, Supplement to Standard Operation and Maintenance Manual, Sacramento River Flood Control Project, Unit No.104 Levees Around Grand Island Reclamation District No.3, and associated "as-built" drawings for system alterations approved by this permit that are to be incorporated into the federal Sacramento River Flood Control Project.

TWENTY: If FEMA certification of the levee by the Corps of Engineers is being considered, the project proponent should contact the U. S. Army Corps of Engineers regarding inspection of this project during construction for FEMA certification purposes.

TWENTY-ONE: The permittee shall contact the U. S. Army Corps of Engineers regarding inspection of the project during construction as the proposed work is an alteration to the existing Federal Flood Control Project that will be incorporated into the Sacramento River Flood Control Project, an adopted plan of flood control.

TWENTY-TWO: The Central Valley Flood Protection Board and Department of Water Resources shall not be held liable for any damages to the permitted encroachment(s) resulting from flood fight, operation, maintenance, inspection, or emergency repair.

TWENTY-THREE: The permittee may be required, at permittee's cost and expense, to remove, alter, relocate, or reconstruct all or any part of the permitted encroachment(s) if removal, alteration, relocation, or reconstruction is necessary as part of or in conjunction with any present or future flood control plan or project or if damaged by any cause. If the permittee does not comply, the Central Valley Flood Protection Board may remove the encroachment(s) at the permittee's expense.

TWENTY-FOUR: The permittee should contact the U.S. Army Corps of Engineers, Sacramento District, Regulatory Branch, 1325 J Street, Sacramento, California 95814, telephone (916) 557-5250, as compliance with Section 10 of the Rivers and Harbors Act and/or Section 404 of the Clean Water Act may be required.

TWENTY-FIVE: The permittee shall be responsible for repair of any damages to the project levee and other flood control facilities due to construction, operation, or maintenance of the proposed project.

TWENTY-SIX: The permittee is responsible for all liability associated with construction, operation, and maintenance of the permitted facilities and shall defend, indemnify, and hold the Central Valley Flood Protection Board and the State of California; including its agencies, departments, boards, commissions, and their respective officers, agents, employees, successors and assigns (collectively, the "State"), safe and harmless, of and from all claims and damages arising from the project undertaken pursuant to this permit, all to the extent allowed by law. The State expressly reserves the right to supplement or take over its defense, in its sole discretion

TWENTY-SEVEN: The permittee shall defend, indemnify, and hold the Central Valley Flood Protection Board and the State of California, including its agencies, departments, boards, commissions, and their respective officers, agents, employees, successors and assigns (collectively,

the "State"), safe and harmless, of and from all claims and damages related to the Central Valley Flood Protection Board's approval of this permit, including but not limited to claims filed pursuant to the California Environmental Quality Act. The State expressly reserves the right to supplement or take over its defense, in its sole discretion.

TWENTY-EIGHT: The mitigation measures approved by the permittee and found in its Mitigation and Monitoring Reporting Program (MMRP) are made a condition of this permit. The permittee shall implement all such mitigation measures. However, the measures in the MMRP may be modified to accommodate changed circumstances or new information not triggering the need for subsequent or supplemental analysis as allowed by law under CEQA Guidelines Sections 15062 or 15063 with advance notice of the proposed changes and submittal of supporting documentation for review and comment to the Staff Environmental Scientist of the Central Valley Flood Protection Board.

TWENTY-NINE: If the project, or any portion thereof, is to be abandoned in the future, the permittee or successor shall abandon the project under direction of the Central Valley Flood Protection Board and Department of Water Resources, at the permittee's or successor's cost and expense.

THIRTY: Upon completion of the project, the permittee shall submit as-built drawings to: Department of Water Resources, Flood Project Inspection Section, 3310 El Camino Avenue, Suite LL30, Sacramento, California 95821.

THIRTY-ONE: No construction work of any kind shall be done during the flood season from November 1 to April 15 without prior approval of the Central Valley Flood Protection Board.

THIRTY-TWO: Cleared trees and brush shall be completely burned or removed from the floodway, and downed trees or brush shall not remain in the floodway during the flood season from November 1 to April 15.

THIRTY-THREE: The permitted encroachment(s) shall not interfere with operation and maintenance of the flood control project. If the permitted encroachment(s) are determined by any agency responsible for operation or maintenance of the flood control project to interfere, the permittee shall be required, at permittee's cost and expense, to modify or remove the permitted encroachment(s) under direction of the Central Valley Flood Protection Board or Department of Water Resources. If the permittee does not comply, the Central Valley Flood Protection Board may modify or remove the encroachment(s) at the permittee's expense.

THIRTY-FOUR: During construction of the project, any and all anticipated or unanticipated conditions encountered which may impact levee integrity or flood control shall be brought to the attention of the Flood Project Inspector immediately and prior to continuation. Any encountered abandoned encroachments shall be completely removed or properly abandoned under the direction of the Flood Project Integrity and Inspection Branch Inspector.

THIRTY-FIVE: The stability of the levee shall be maintained at all times during construction.

THIRTY-SIX: The permittee shall be responsible for all damages due to settlement, consolidation, or heave from any construction-induced activities.

THIRTY-SEVEN: All fencing, gates and signs removed during construction of this project shall be

replaced in kind and at the original locations. If it is necessary to relocate any fence, gate or sign, the permittee is required to obtain written approval from the Central Valley Flood Protection Board prior to installation at a new location.

THIRTY-EIGHT: All temporary fencing, gates and signs shall be removed upon completion of the project.

THIRTY-NINE: Earthen fill on the levee slope shall be keyed into the existing levee section with each lift.

FORTY: Backfill material for excavations within the levee section and within 10 feet of the levee toes shall be placed in 4- to 6-inch layers, moisture conditioned above optimum moisture content, and compacted to a minimum of 90 percent relative compaction as measured by ASTM Method D1557-91.

FORTY-ONE: Density tests by a certified materials laboratory will be required to verify compaction of backfill within the levee and new seepage berm fill .

FORTY-TWO: Fill material shall be placed only within the area indicated on the approved plans.

FORTY-THREE: All earthen fill material shall be imported impervious material with 20 percent or more passing the No. 200 sieve, a plasticity index of 8 or more, and a liquid limit of less than 50 and free of lumps or stones exceeding 3 inches in greatest dimension, vegetative matter, or other unsatisfactory material. Fill material shall be compacted in 4- to 6-inch layers to a minimum of 90 percent relative compaction as measured by ASTM Method D1557-91.

FORTY-FOUR: All seepage berm permeable fill material shall comply with the submitted plans and specifications

FORTY-FIVE: The fill surface area shall be graded to direct drainage away from the toe of the levee and berm.

FORTY-SIX: The project site shall be restored to at least the condition that existed prior to commencement of work.

FORTY-SEVEN: All debris generated by this project shall be disposed of outside the floodway and off the project site.

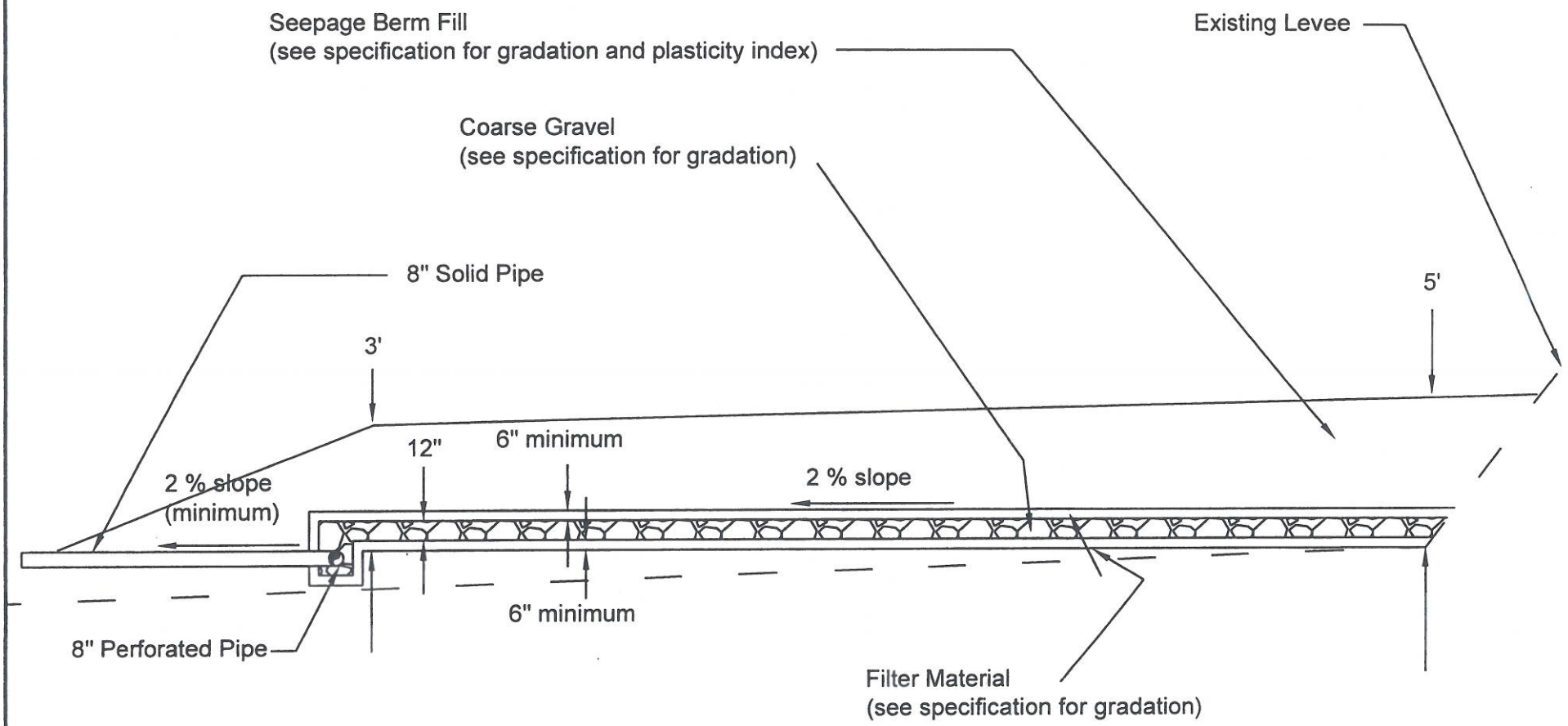
FORTY-EIGHT: The permittee shall replant or reseed the levee slopes to restore sod, grass, or other non-woody ground covers if damaged during project work.

FORTY-NINE: Any additional encroachment(s) in the floodway, on the levee section or within ten (10) feet of the landward levee toe will require an approved permit from the Central Valley Flood Protection Board and shall be in compliance with the Central Valley Flood Protection Board's regulations (Title 23 California Code of Regulations).

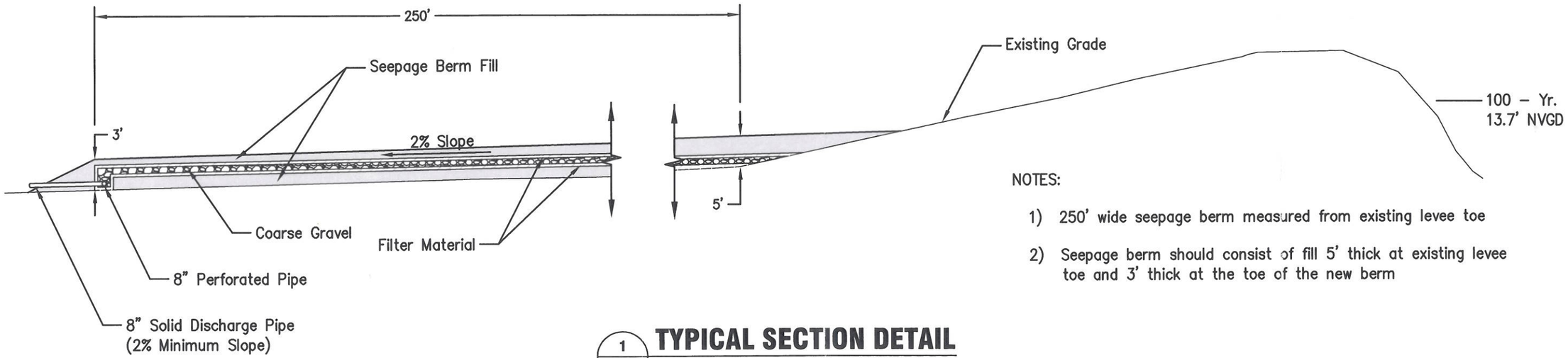
FIFTY: By acceptance of this permit, the permittee acknowledges the authority of the Central Valley Flood Protection Board to regulate all future encroachments along this levee reach including those

that may encroach upon alterations approved by this permit prior to incorporation into the federal Sacramento River Flood Control Project by the Corps of Engineers.

FIFTY-ONE: The permittee shall comply with all conditions set forth in the letter from the Department of the Army dated September XX, 2010, which is attached to this permit as Exhibit A and is incorporated by reference.




| | | | |
|---|---|---|---|
| NO SCALE | Seepage Berm<br>Steamboat Slough Stations 332 to 342<br>Grand Island, California | **Typical Detail - Seepage Berm** | |
| | **Hultgren - Tillis Engineers** | Project No. 249.02 | Plate No. 4 |

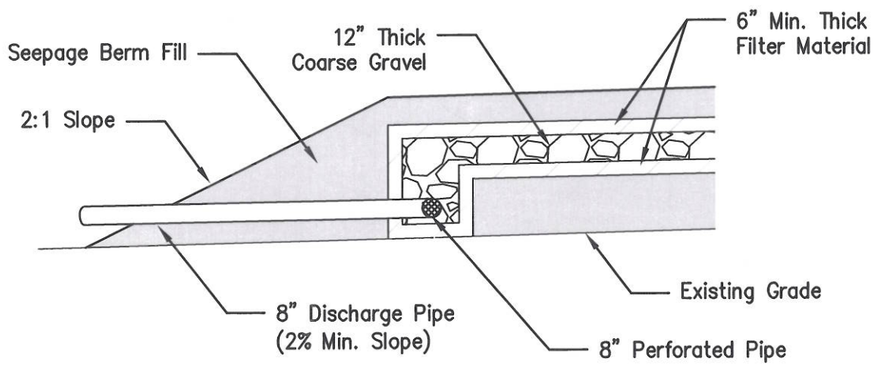



NOTES:

1) 250' wide seepage berm measured from existing levee toe
2) Seepage berm should consist of fill 5' thick at existing levee toe and 3' thick at the toe of the new berm

## 1 TYPICAL SECTION DETAIL

**STA 334+00 TO 343+00**
**SCALE: N.T.S.**

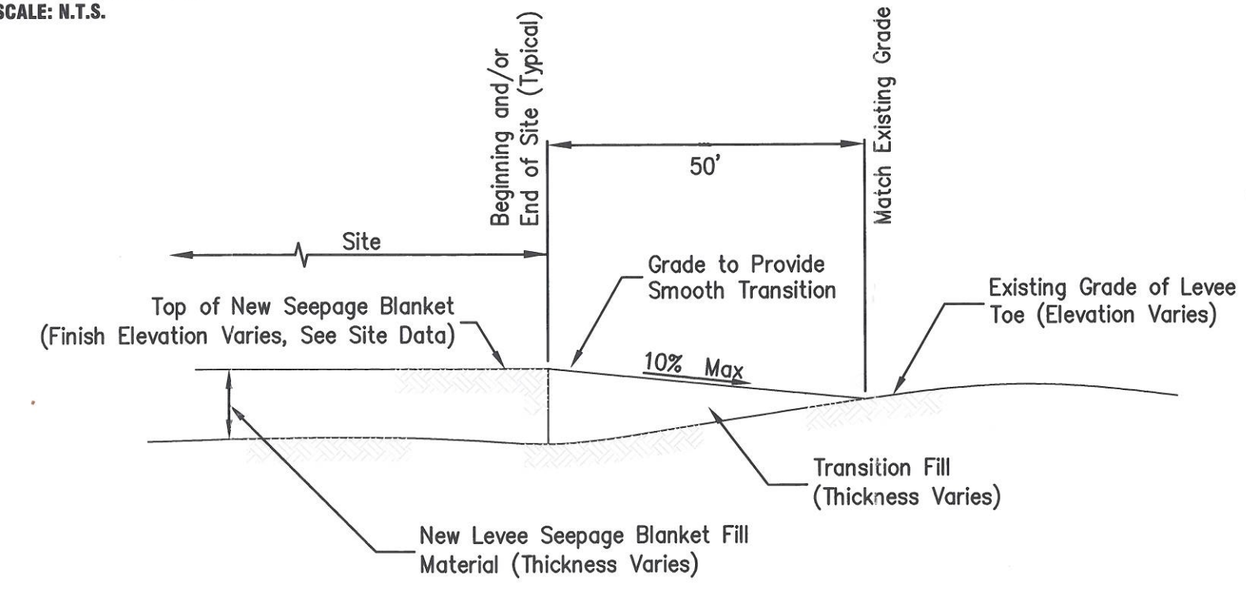



## 2 PIPE DETAIL

**STA 343+00**
**SCALE: N.T.S.**

NOTES:

1) 8" Perforated pipe runs along toe of Seepage Blanket
2) 8" Discharge pipe drains into lateral ditch on South end of site.




## 3 TRANSITIONAL ZONE DETAIL

**STA 334+00 and STA 343+00**
**SCALE: N.T.S.**

NOTES:

1) Grade to provide smooth transition between exisitng grade and Seepage Blanket.
2) Grade Transition Zone in accordance with Technical Specifications.

MBK ENGINEERS
1771 Tribute Road, Suite A
Sacramento, California 95815
Phone: (916) 456-4400 • Fax: (916) 456-0253

| NO. | DATE | REVISION |
|---|---|---|
| | | |

RECLAMATION DISTRICT NO. 3
GRAND ISLAND

# PROJECT DETAILS

| | |
|---|---|
| SCALE: | N.T.S. |
| JOB NO: | 3900.1 |
| BY: | JAB |
| CHK: | --- |
| DATE: | 04/26/2010 |
| SHEET | 5 OF 5 SHEETS |

A California Corporati
Specializing in Geotechnical Engineer.

Hultgren-Tillis Engineers

December 10, 2009
File No. 249.02

MBK Engineers
1771 Tribute Road, Suite A
Sacramento, California 95815-4401

Attention: Mr. Gilbert Cosio

**Geotechnical Evaluation**
**Seepage Berm**
**Reclamation District 3**
**Steamboat Slough Stations 332 to 342**
**Grand Island, California**

Dear Mr. Cosio:

## INTRODUCTION

This letter presents our geotechnical recommendations for the design of a seepage berm planned along a section of levee located between approximate Reclamation District 3 Stations 332 and 342 on the west side of Grand Island adjacent to Steamboat Slough.

## PROJECT INFORMATION

The levee stretch has a history of seepage. We conducted a geotechnical investigation of the subject site to evaluate causes of existing seepage and to develop solutions to reduce or control seepage. The results of our investigation and our conclusions and recommendations were presented in a written report dated August 8, 2008. The subsurface soil and groundwater conditions were presented in our August 8, 2008 report, and will not be repeated here. We presented three alternatives in our August 8, 2008 report to reduce seepage: 1) Seepage Berm, 2) Cutoff Wall, and 3) Gravity Relief Well System.

We presented design criteria for relief wells in a letter dated December 23, 2008. We understand that the seepage berm option is also under consideration. Our current scope of work consists of developing design criteria for the design of a seepage berm for the site using the United States Army Corps of Engineers (USACE) design method and existing subsurface data from our geotechnical investigation. This letter presents geotechnical recommendations for the design of a seepage berm.

## SEEPAGE BERM ANALYSIS

Our seepage analysis was conducted using SEEP/W 2007, a two-dimensional, finite element, computer program.

We used Station 335 for our analysis. The right boundary of the model represents the centerline of Steamboat Slough. The left boundary of the model is located in the open field of Grand Island, about 2,000 feet from the centerline of the existing levee. The bottom boundary represents the base of the upper sand stratum at about Elevation -24 feet.

We evaluated seepage for the existing levee conditions and for alterations to the existing levee that includes a seepage berm. The first levee configuration represents the existing levee condition, which consists of a levee section with an approximately 30-foot-wide levee crest at Elevation +22 feet. The second levee configuration includes the addition of a seepage berm. We evaluated different widths of the seepage berm. The typical berm is 5 feet thick at the existing levee toe and 3 feet thick at the landside edge of the toe berm. We designed the seepage berm to include a drainage layer at the base of the berm. Water that collects in the berm will be transmitted in a drain pipe and then directed into the existing drainage system on the island.

We evaluated two water levels in Steamboat Slough for our seepage analysis. The first condition is intended to represent an average existing condition with a water elevation of +2 feet. The second condition represents a flood condition with a water elevation of +12 feet. The groundwater elevation at the landside boundary was assumed to be -11 feet.

Five soil units were included in our models: "Existing Levee Fill", "Upper Clay", "Upper Sand", "New Berm Fill", and "New Drain". The geometry of the model and the soil permeability used in our seepage analysis are shown on Plate 1 (attached). The permeability of the Upper Sand was developed based on the Kozeny-Carman equation, and the remaining permeability values were assumed values based on the material types.

We initially performed modeling with existing conditions and calibrated the model to provide heads within the aquifer roughly consistent with the heads measured in our piezometers. After setting up the model, we analyzed existing conditions for the flood level. The result from existing condition at flood stage is presented on Plate 2. An average vertical exit gradient of about 0.9 was calculated in the area to the landside of the levee toe. We also conducted "Blanket Theory" analysis using the simplified method in the USACE design manual (EM 110-2-1913), and an average vertical exit gradient of 1.2 was calculated at the existing levee toe.

The criteria in the USACE Sacramento District's Geotechnical Levee Practice guideline document indicates that the vertical exit gradient should be 0.5 or larger at the levee toe. The allowable seepage gradient is higher at toe of a seepage berm. The USACE guideline allows a gradient of up to 0.8 at the seepage berm toe.

The results for the seepage model for a 250 feet wide seepage berm at flood stage are presented on Plate 3. The average vertical exit gradient in front of the toe of the new seepage berm was calculated to be about 0.6 for the SEEP/W modeling. The exit gradient from Blanket Theory is well below 0.5. The exit gradient meets the USACE criteria.

**SEEPAGE BERM DESIGN**

Based on the results of our analysis we recommend that the seepage berm be 250 feet wide measured from the existing levee toe. The new seepage berm should consist of fill, 5 feet thick at the existing levee toe and 3 feet thick at the toe of the new berm. A typical detail of the toe berm and drainage blanket is presented on Plate 4.

The seepage berm should include a two-foot-thick drain blanket at the bottom of the berm. This drain blanket thickness can be counted toward the recommended berm thicknesses presented above. Seepage from the drain blanket should be collected in a drain pipe located beneath the toe of the seepage berm. The material used for the drain blanket should meet the gradations

presented in Tables 1 and 2. The drain pipe should be sloped to drain and carry the drainage by gravity to the existing drainage ditches.

Table 1: Filter Gradation

| Sieve | Percent Passing by weight |
|---|---|
| 3/4-inch | 100 |
| #4 | 80-100 |
| #8 | 60-80 |
| #30 | 10-65 |
| #100 | 0-25 |
| #200 | 0-5 |

Table 2: Coarse Gravel

| Sieve | Percent Passing by weight |
|---|---|
| 3-inch | 100 |
| 3/4-inch | 60-100 |
| #4 | 15-45 |
| #16 | 0 |

Fill for the seepage berm should have at least 20 percent fines passing the number 200 sieve and 100 percent passing the 2-inch sieve. The fill should have a Plasticity Index of at least 8 and less than 40, and a maximum Liquid Limit of 45. Samples of fill material should be submitted to us for approval before importing to the site.

The site should be cleared and grubbed of surface and subsurface deleterious matter including trees, grasses, other vegetation and debris designated for removal. The site should be stripped to sufficient depth to remove vegetation and soil containing roots. Tree roots greater than 1-inch in diameter should be removed. Stripped and grubbed materials should be removed from the site and should not be used as fill.

Surfaces in areas to be filled should be scarified to a depth of at least 8-inches or the full depth of shrinkage cracks, whichever is deeper. The scarified soil should be moisture conditioned to at least 3 percent over optimum moisture content and compacted to at least 90 percent relative compaction. ASTM test D-1557 should be used to establish the reference values for computing optimum moisture content and relative compaction. If soft or yielding soils are present during subgrade preparation or fill compaction, they should be scarified, moisture conditioned and compacted or removed by excavating to expose firm soil.

Fill should be placed in lifts 8-inches or less in loose thickness and moisture conditioned to at least optimum moisture content. Moisture conditioning should be performed before compaction. Each lift should be methodically compacted to at least 90 percent relative compaction. A sheepsfoot compactor or equivalent equipment should be used for compacting clay soils. Material that fails to meet the moisture or compaction criteria should be loosened by ripping or scarifying, moisture conditioned, and then recompacted.

Before construction, we should review project foundation and grading plans and specifications for conformance with the intent of our recommendations. During construction we should observe and/or test the geotechnical aspects of grading and foundation construction including but not limited to subgrade preparation, placement and compaction of fill, and foundation excavations. If conditions are encountered during construction that are not consistent with those described herein, we should be contacted to review our recommendations and provide alternatives, if appropriate.

If you have any questions, please call.

Sincerely yours,

**Hultgren-Tillis Engineers**

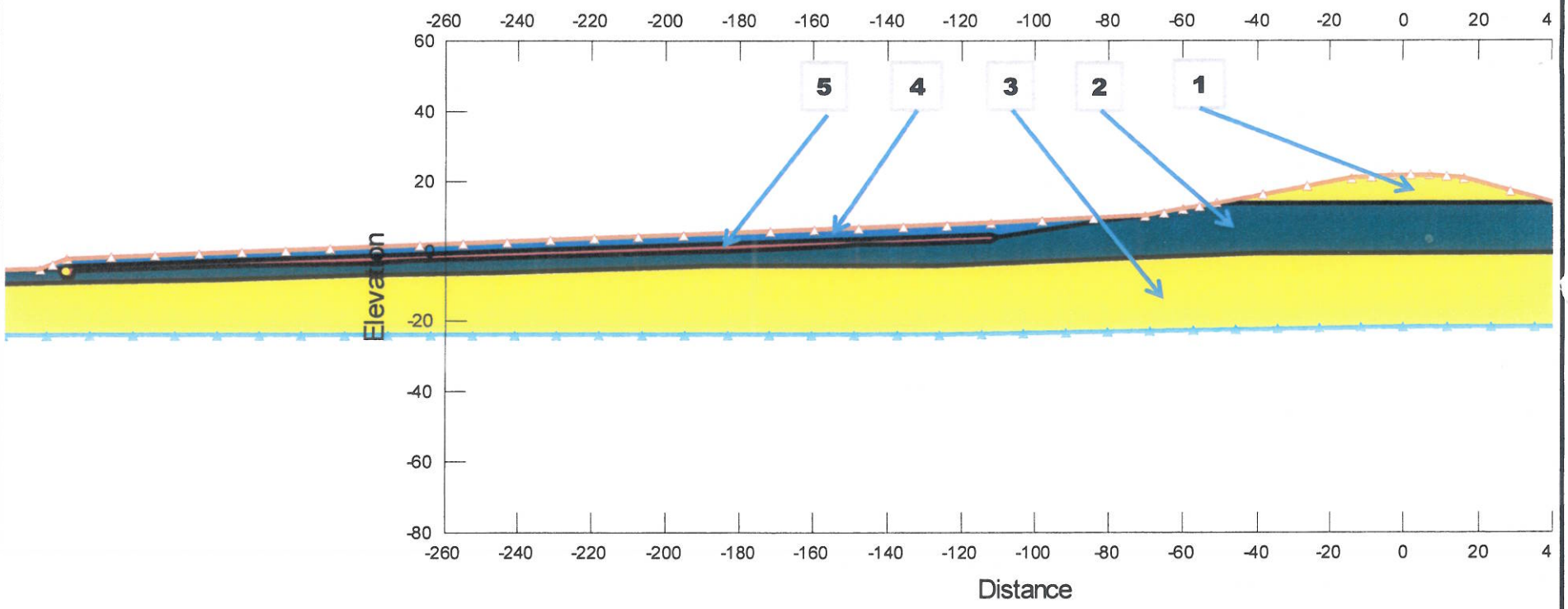

R. Kevin Tillis
Geotechnical Engineer

EM:RKT:db:lm

Attachments: Plate 1 – Geometry Model
Plate 2 – Flood Condition, Existing Levee
Plate 3 – Flood Condition, Existing Levee with 250-wide Berm
Plate 4 – Typical Detail - Seepage Berm

2 copies submitted

File No. 24902L03 design memo.doc




| | Soil Unit | Horizontal, $K_h$ (cm/sec) | $K_v / K_h$ |
|---|---|---|---|
| 1 | Existing Levee Fill | $7 \times 10^{-2}$ | 0.25 |
| 2 | Upper Clay | $1 \times 10^{-5}$ | 10.00 |
| 3 | Upper Sand | $7 \times 10^{-2}$ | 0.25 |
| 4 | New Berm Fill | $1 \times 10^{-5}$ | 10.00 |
| 5 | New Drain | $1 \times 10^{0}$ | 1.00 |

Seepage Berm
Steamboat Slough Stations 332 to 342
Grand Island, California

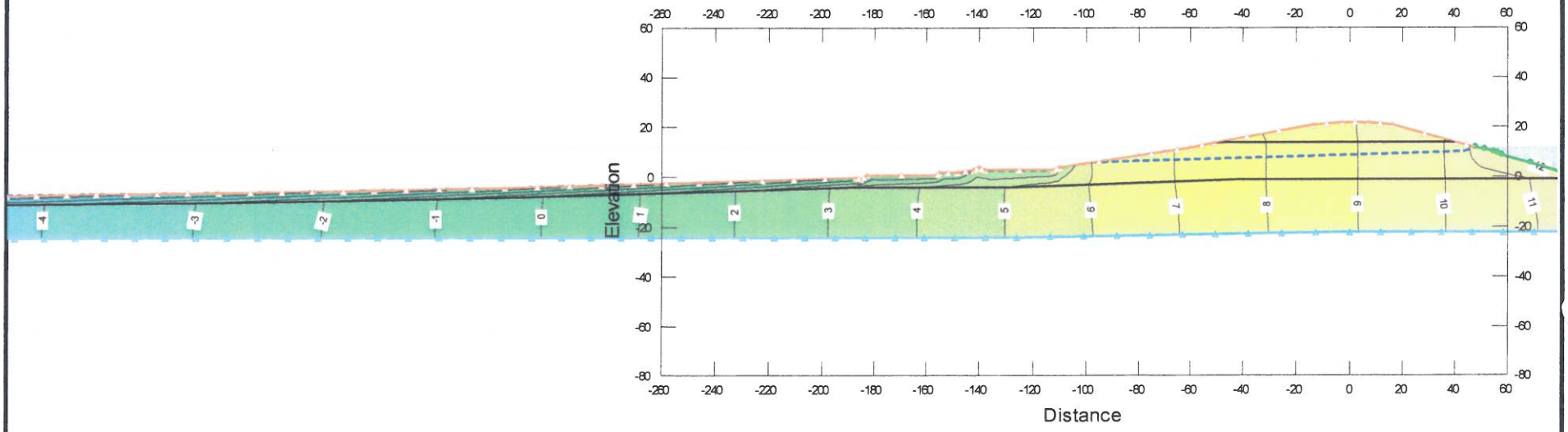
**Existing Conditions**

Approx. Scale: 1" = __'

**Hultgren - Tillis Engineers** | Project No. 249.02 | Plate No. 1

Geometry Model

Total Head Contours

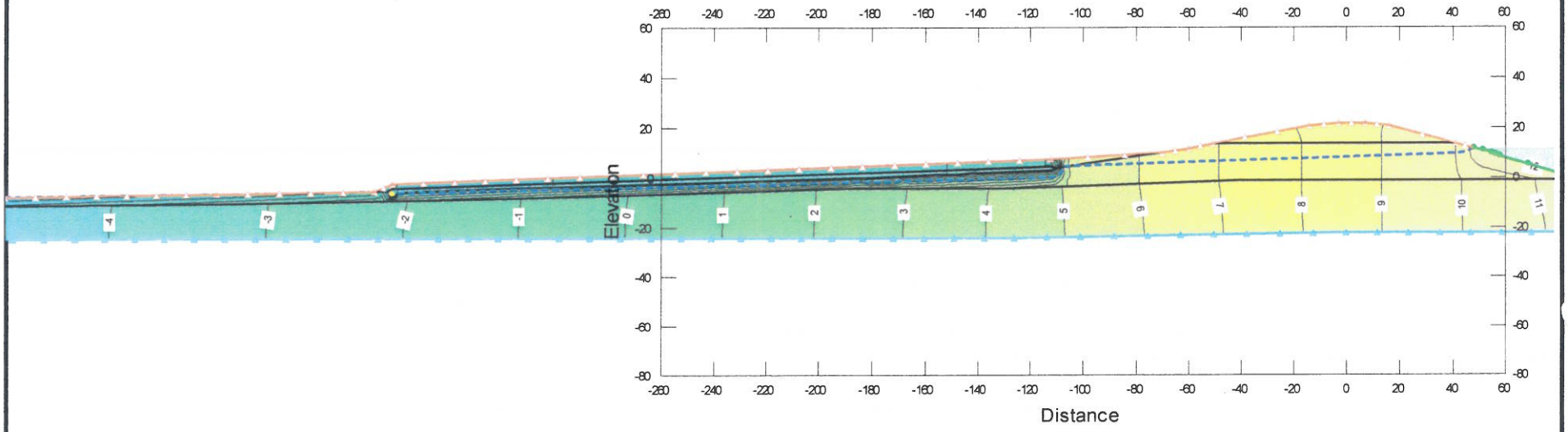



Approx. Scale: 1" = __'

| | | |
|---|---|---|
| Seepage Berm<br>Steamboat Slough Stations 332 to 342<br>Grand Island, California | **Seepage Analysis**<br>**Flood Condition (Water at Elev. +12')**<br>**Existing Levee** | |
| **Hultgren - Tillis Engineers** | Project No. 249.02 | Plate No. 2 |

Geometry Model

Total Head Contours




Approx. Scale: 1" = __'

| | | |
|---|---|---|
| Seepage Berm<br>Steamboat Slough Stations 332 to 342<br>Grand Island, California | **Seepage Analysis**<br>**Flood Condition (Water at Elev. +12')**<br>**Existing Levee with 250'-Wide Berm** | |
| **Hultgren - Tillis Engineers** | Project No. 249.02 | Plate No. 3 |